Interactive Engagment Capabilities as an Indicator of E-Learning Systems' Usability

Aljawharah Al-Muaythir, Khalid Alnafjan, Lamia Al-Kwai
Software Engineering Department, Collage of Computer Science, King Saud University
Riyadh, Saudi Arabia
aljoharah1408@windowslive.com, kalnafjan@ksu.edu.sa, lalkwai@kacst.edu.sa

***Abstract*—Interactive engagement is easier to achieve in traditional learning environments (where face-to-face interaction is assured) than in e-learning environments. Therefore, a set of functionalities should be supported in e-learning systems to allow an acceptable level of interactive engagement, such as whiteboards, chartrooms, discussion boards, etc. In this study, some analysis and evaluation was conducted for a number of open source e-learning systems regarding their support for functionalities that aids in creating an interactively engaging learning environment. The evaluation included ATutor, Claroline, Dokeos, Integrated Learning, Information and Work Cooperation System (ILIAS), Modular Object-Oriented Dynamic Learning Environment (Moodle), Online Learning and Training (OLAT), and Sakai. The evaluation result showed that Moodle and Dokeos achieved the best coverage of all possible interactive engagement-supporting capabilities available, thus proving its superiority over other e-learning systems included in this study in providing an interactively engaging learning environment.**

Keywords— Interactive Engagment; Usability; E-learning; Open source.

I. INTRODUCTION

Educational Systems are evolving to meet the society's needs for learning systems that save time, money and the environment. E-learning systems, the use of information and communication technologies in the learning process, are emerging to meet those needs. They are the best solution for students and instructors that live in separate locations and for those who have temporal difficulties. Many benefits of e-learning systems are discussed in the literature, such as the flexibility of the material and time that is given to students, and more opportunities to ask questions and express thoughts. Also, it reduces the dependence on time constraints for teacher/lecturer and supports the accessibility to the course materials based on student's election [1]. In addition, J. Capper [2] listed several valuable benefits, including the fact that new learning strategies and approaches become economically feasible through e-learning systems. For instance, it becomes feasible to utilize faculty anywhere in the world and to put together faculty teams that include master teachers, researchers, scientists, and experienced professional developers. Also, group collaboration can be achieved by means of electronic messaging and shared conversations tools that give the participants the opportunity to work together as groups despite their physical locations.

The success of e-learning systems had led to the development of many e-learning platforms -either open-source or close-source- that support various tools and technologies to allow a good blend of learning capabilities in order to optimize the learning process. E-learning may be synchronous, where the learning among all participants occurs in real time, or asynchronous, where participants learn at there own pace. Weather the e-learning system was designed to be synchronous or asynchronous, participants are usually at various locations. Therefore, the assumption that e-learning systems are recreation of traditional systems is wrong due to the lack of face-to-face communication, body language, social cues in e-learning, but are essential in producing an engaging learning environment. Actually, traditional classrooms allow instructors to be aware of the level of student's understanding and easily employ some techniques to keep the students active and engaged. However, in virtual classrooms, that will be more difficult because of the lack of face-to-face interactions among students and instructors. In this situation, instructors must have access to some tools offered by the e-learning platform to promote the learning process [3]. Consequently, this allows instructors to make sure that students understand well, and keep them engaged by using several forms of interaction including: the interaction of students with the instructor, their fellow students, or the content. Instructors expect to use E-learning platforms that have adequate tools -whiteboards, audio and video are some examples of such tools that can be used in this context- to support the interactive engagement in virtual classroom.

Because of the remote nature of the e-learning activities, usability is of special importance in e-learning systems [4]. Furthermore, the level of interactive engagement supported in e-learning systems is found to be vital for achieving effectiveness [5], which is a core measurement of usability based on its definition in the ISO (International standard organization) 9241 standard-: "*The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use*".

Due to the importance of the supportability of interactive engagement in e-learning systems, this paper will emphasize how interactive engagement functionalities supported by e-learning systems affect their achieved usability. Furthermore, seven widely used open-source E-learning systems (Moodle [6], ILIAS [7], Sakai [8], ATutor[9], Claroline [10], Dokeos[11], and OLAT[12]) will be evaluated based on their interactive

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engagement capabilities.The comparison will be based on the offered synchronous and asynchronous tools by each one of the seven systems to support and meet the interactive engagement requirement. First, we will list and describe the tools that can be used generally in virtual classroom to support interactive engagement. Then, we will check the availability of these tools in each one of the e-learning systems included in this study. Finally, we will conclude our research with the usability evaluation –from the interactive engagement point of view- of these e-learning systems. In the next section we discuss the importance of interactive engagement in assessing the usability of e-learning systems, and in pedagogy. After that, we provide an overview of e-learning systems in general, and the e-learning systems that will be covered by this study. Following that, we will explain the applied evaluation approach. Then, we will list and explain the functionalities that support interactive engagement in e-learning systems, and on which we will base our comparison upon. Finally, we will present the evaluation results and conclude with our findings.

II. INTERACTIVE ENGAGMGNET IMPORTANCE

Hake [13] defines interactive engagement methods as ‘‘*those designed at least in part to promote conceptual understanding through interactive engagement of students in heads-on (always) and hands-on (usually) activities which yield immediate feedback through discussion with peers and/or instructors*”, placing an emphasis on challenging the student to ‘think’ actively, which ensures that students pay and keep attention to the instructor and the material that is being presented. In this paper, we are interested in interactive engagement from two aspects: its importance in assessing the effectiveness (as a direct indicator of systems’ usability) of e-learning systems, and its importance in pedagogy to achieve educational goals.

A. Interactive Engagement Importance in Usability Assessment of E-learning systems

Interactive engagement is one of the important needs by users (learners and instructors) that must be considered and met to produce an e-learning system with high usability. In Michael Allen's guide to e-learning [28], interactive engagement capabilities is one of the fundamental services that should be provided in e-learning systems. Furthermore, one of the three shifts that should be adopted by e-learning describes in this guide is the shift from passive learning to interactively engaging learning [29].

From usability point of view, each system has a set of user profiles and each should be able to achieve a number of tasks properly. Learners and instructors are the common user profiles of e-learning systems and should be able to perform tasks through offered functionalities in order to fulfill the interactive engagement user requirement [17].

In addition, learners and instructors have the need to use collaborative and interactive tools to share their tasks and ideas with each other [18]. Furthermore, the use of interactive engagement materials and tools significantly enhances the user experience in e-learning [30]. Given the importance of these requirements (interactive engagement and collaboration functionalities), to achieve an effective learning process through the use of e-learning systems, the evaluation of e-learning usability based on the design heuristics is not enough. Thus, users may abandon an e-learning system if the interactive engagement –as an essential pedagogy- is not supported.

Some previous studies [19] [20] have established a framework to evaluate the usability of e-learning systems, which combine the instructional design and usability heuristics. Another, [17], has proposed a systematic approach based on user requirements and goals.

One of the important studies that considered the interactive engagement as one of the usability parameters in their proposed evaluation framework is [21]. This framework is based on learner-centered-perspective and combined usability and instructional design parameters, such as learnability, consistency, multimedia use, and interactive engagement. Also, for each parameter, there is a group of measurement criteria, such as the use of games and media as measurement criteria for interactive engagement parameter.

These previous studies indicate that the usability of e-learning systems can be affected by the pedagogies and learning goals that should be placed under great importance, such as interactive engagement, and the need to combine the pedagogical guidelines with design heuristics to create effective usability evaluation frameworks for e-learning systems.

B. Interactive Engagement Importance in Pedagogy

Communication and interactions between instructors and students are essential for the quality of learning. Interaction in pedagogy between instructors and students applies to any form of communication, whether initiated by the instructor or by the student. The four types of interaction that may occur in education are learner-to-content, learner-to-learner, learner-to-technology, and learner-to-teacher [14]. The occurrence of these types of interactions is essential in creating an interactive engaging learner environment and diminishing the learning barriers. Many forms of communication may be applied in order to achieve an interactive and engaging learning environment, including:

- Discussions between the instructor and the student, a group of students, or within groups of students.
- Student Expressions and thoughts about presented topics.
- Feedback provided from instructors on students discussion, academic performance, etc.
- Group activities.
- Applied learning strategies such as interactive video, audio, questionnaires, games, etc.

Educators and pedagogical researchers have placed great importance in engaging the learner; and “To teach is to engage students in learning” [15] is a famous quote in pedagogy. Moreover, gains from interactively engaging

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the learner vary from enhancing critical thinking, to reducing student attrition [16].

III. OVERVIEW OF E-LEARNING SYSTEMS

E-learning refers to the use of Information and communication technologies in education and learning. It is enabled through the use of e-learning systems, which offer a wide range of capabilities and features from simple asynchronous content management, to synchronous virtual classrooms. The most agreed upon terms used to classify such systems based on their capabilities and features are: Learning Management System (LMS), which are software applications that deliver, manage, and track e-learning education courses\ training programs, Content or Course Management System (CMS), which are software applications that manage –in terms of creation and administration-content on educational\training websites, Learning Content Management System (LCMS), which are software applications that fulfill the characteristics of a LMS (administrative and management) and a CMS (content creation and administration), and Virtual Learning Environment (VLE), which are software systems that provide virtual classrooms for students and teachers to interact with each other by the integration of web 2.0 tools.

The features and capabilities that are implemented in an e-learning system depend on specific institutional needs and targeted markets. Though, common features in most e-learning systems include [22]:

- Structure – organization of all learning-related functions into one system.
- Security – protection from unauthorized access to all system content.
- Registration – finding, selecting or assigning courses.
- Delivery – delivery of learning content to learners.
- Interaction – including some types of learner interaction: with the content, with other learners, with instructors, and with course administrators.
- Assessment –collection, tracking, and storing of assessment data.
- Tracking – tracking of learner data indicating progress\usage.
- Reporting – extraction and presentation of required information.
- Record keeping – storage and maintenance of data about learners.
- Personalization – configuration of e-learning system to match personal preferences\organizational needs.
- Integration – the ability to exchange data with external systems.
- Administration – centralized management of all system functions.

Due to the notable advantages of e-learning and the widespread application of information and communication technologies, many organizations and schools are making more investments in acquiring e-learning systems to support and improve learning [23]. Cost-effective alternatives to buy or develop in-house e-learning systems are open source e-learning systems. Currently, there are more than 250 commercial e-learning systems and more than 45 of them are Open Source Software (OSS) [24].

Among the most popular open source e-learning systems are Moodle, Dokeos, Claroline, ILIAS, OLAT and others.

To ensure a fair argument, this paper will compare seven e-learning systems under the same category -open source- namely ATutor, Claroline, Dokeos, ILIAS, Moodle, OLAT, and Sakai. The selection of open source over proprietary e-learning systems is because of the advantages they provide, such as [25]:

- Ease of customization to meet specific organizational needs because their code is open.
- Ease of localization by modifying language preferences.
- No licensing costs.
- Faster bug fixes because of active supporting communities.
- Compatibility and extensibility with third party add-ons.

Following is a brief description of each one of the e-learning systems under comparison.

A. *Moodle*

Moodle is a free, open source educational software platform categorized as an LMS and VLE. It was developed with a focus on helping educators create online courses that are interactive and collaborative. It was released to the public in 2002 and its high modularity and ease of use are of its most appealing advantages and is what makes it most popular among small-to-medium and higher education business markets.

B. *ILIAS*

ILIAS is a free, open source, web based LMS and VLE. Although the project started in 1997, it was only released for public in 2000 as open source software. ILIAS is commonly used in public and private institutions and companies because of its multi-purposes: course player tool, authoring tool, and communication and collaboration platform. It is also popular in the security and defense sector because of its defense-specific security and interoperability requirements considerations.

C. *Sakai*

Sakai is a free, open source educational software platform considered as an LMS, CMS and VLE. Sakai was built by a consortium of five large U.S. universities and is based on existing tools contributed by each of these universities. It was first released to the public in 2005 and has gained popularity for its scalability, security, and high support for end features, which made it especially popular among large universities.

D. *ATutor*

ATutor is a free, open source LCMS and VLE. ATutor was designed with emphasis on accessibility (access alternatives to screen elements, and text alternatives to visual screen elements) and adaptability (with various teaching and learning scenarios). ATutor was first released

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in 2002, and it is effective for small and large organizations presenting their materials on the Web, or delivering online courses.

E. Claroline

Claroline is a free open source LMS and LCMS that serves the educational more than the corporate sector. It provides a space for training and collaboration and was released for the public in 2001. Claroline is based on pedagogical principles found in literature. It is popular for its high adaptability to different training/learning contexts, customizability by offering a flexible work environment, and the valuable offered tools that enable the instructor to use it in order to create rich course material.

F. Dokeos

Dokeos is a free open source corporate learning suite, which is technically considered as an LMS, and VLE. It has started as a company and LMS in 2004. It has four separate components to build e-learning content, to handle interaction with learners, to sell a course catalog, and for assessment and certification. It is popular for its high simplicity and reporting capabilities. Also, it supports flexible free or non-free extended tools such as authoring, video conferencing, quiz building, assessment, and reporting to administration tools.

G. OLAT

OLAT is a free open-source learning platform that launched in 1999. It is considered as an LMS that offers several languages and features that support e-assessments, collaborative groups, and interactive/effective learning.

IV. Applied Evaluation Approach

Here, we will compare and evaluate seven most popular open source e-learning systems, described above, namely, ATutor, Claroline, Dokeos, ILIAS, Moodle, OLAT, and Sakai. This evaluation is conducted to check the available functionalities that may support and enhance interactive engagement in the learning process offered by these systems.

To evaluate such systems, we investigated eight synchronous and asynchronous capabilities that can aid to support interactive engagement. These capabilities are (virtual classroom, messaging, forums, chat room, wikis, groups, games, multimedia support).

Our evaluation consisted in installing such systems, and using them as regular users with the help of systems manuals/documentations (if needed). We used a score scale (0-3) for the evaluation; 0 if the system does not offer the capability, 1 if the capability is partially supported and system does not offer the adequate main functionalities, 2 if the system supports the capability by offering the main functionalities, 3 if the system provides more functionalities than the main ones, so the capability is highly supported by the system.

V. Interactive Engagement Capabilities

In this section, we will list and explain the capabilities that support interactive engagement in e-learning systems, and on which we will base our comparison between ATutor, Claroline, Dokeos, ILIAS, Moodle, OLAT, and Sakai.

Mainly, most of these capabilities-if supported by a system- are offered as plugins or by integration, so users can install and configure any one of these functionalities based on his needs. Communication, collaboration, and cooperation are very important factors to introduce interactive engagement. Based on that, we selected eight synchronous and asynchronous functionalities that support these three factors and may lead to obtain an interactively engaging learning environment. The selected capabilities are as follows:

1. Virtual classroom: it includes three main capabilities which are:
   - Whiteboard: synchronous tool that keeps the students focused during class by allowing them to clarify ideas, and share what they draw/write on it.
   - Web and video conferencing: synchronous tool allows users in separate multiple locations to create real time classroom by using telecommunication technologies to simultaneously communicate two-way video and audio transmissions, content sharing, and slideshow presentation.
   - Screen sharing: by depending on number of protocols, it is a feature that allows the user to connect to a computer in separate locations to see that computer's desktop, and interact with it as if it were local.
2. Messaging: asynchronous tool that allows students to send emails/messages to their fellow students or instructors and vice versa.
3. Forums: it includes:
   - News/announcement forum: asynchronous tool that allows users to announce about any event/activity related to courses.
   - Discussion forum: asynchronous tool for students and their instructor to discuss any ideas or details related to any course class/ lecture or issues.
4. Chat room: synchronous text based discussion.
5. Wikis: asynchronous tool used to create/update collaboratively web pages/documents by students and instructors.
6. Groups: asynchronous tool that allows instructor to divide students as groups to do a specific task or activity.
7. Game: this functionality is used to apply game based learning by offering some games that achieve a specific goal in the learning process.
8. Multimedia support: a main capability that support adding/embedding, sharing, and viewing video/audio/image files related to course/class content.

VI. Evaluation Results

In this section, we present the evaluation results of our study. Table 1 shows the results for each system based on the offered functionalities. Mainly, all systems offer a basic set of synchronous and asynchronous functionalities

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that help the instructor to increase the level of interactive engagement in a course.

The results in Table 1 show that Moodle and Dokeos achieve higher mean value than other systems, and that means they offer more functionalities related to interactive engagement, ILIAS and ATutor offer less functionalities than Moodle and Dokeos. Sakai and Claroline achieve the same value of interactive engagement support. Although these systems achieve different values of support, they provide the main and important interactive engagement capabilities. One of these important capabilities-virtual classrooms- is slightly supported by OLAT that achieve the lowest support value.

Although the scores that were achieved appear to be close, the impact of an additional functionality can increase the usability of the e-learning system greatly [26].

All e-learning system that have been evaluated, other than Moodle and Dokeos, do not support the game functionality, which is a valuable capability that assists to make the learning fun and helps to keep the students focused and engaged. This kind of capability supports game based learning that helps to increase the engagement of students [27].

Also, Sakai Claroline and OLAT do not highly support Multimedia services, which is a basic capability that is used by most e-learning systems to assist the learning process. Multimedia support capability can improve the interaction/communication between students and their instructors by enabling them to share some media related to their course, discuss it, and post comments.

Furthermore, OLAT does not provide enough virtual classroom functionalities, such as whiteboard and video conferencing, to support the interactivity of the learning process.

VII. CONCLUSION

In this paper, we showed that interactive engagement functionalities are essential in evaluating the usability of e-learning systems. The study first investigates the importance of interactive engagement from a pedagogical point of view, and its importance to be supported by e-learning systems to enhance their effectiveness and therefore their usability. After that, we suggested a list of eight capabilities that may provide an interactively engaging e-learning environment. Furthermore, we evaluated a number of open source e-learning systems to check their support for these functionalities. As a result, we found that Moodle and Dokeos can introduce better interactive engagement by supporting more functionalities than ILIAS, ATutor, Claroline, OLAT and Sakai.

Although the results of the evaluation were close, each single functionality adds great value to an e-learning system and its capability of providing an interactive engaging learning environment.

TABLE 1. EVALUATION RESULTS

System / Functionality	Moodle	ILIAS	Sakai	ATutor	Claroline	Dokeos	OLAT
Virtual classroom	3	3	3	3	3	3	1
Messaging	3	3	3	3	2	3	2
Forums	3	3	3	3	2	3	2
Chat Room	3	3	2	3	3	2	3
Wikis	3	3	3	3	3	3	3
Groups	2	3	2	3	3	3	3
Game	2	0	0	0	0	2	0
Multimedia support	3	3	2	3	2	3	2
Mean value	2.75	2.62	2.25	2.62	2.25	2.75	2

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